

SHORT REPORT

Viewing less to see better

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J Neurol Neurosurg Psychiatry 2002;**73**:195–198

Objective: To assess the efficacy, as well as the long term duration, of a new procedure for the rehabilitation of visuospatial neglect in patients with right hemisphere stroke.

Methods: Patients with right unilateral hemispheric damage identified with neglect were assigned to a treatment (T+) or a control (T-) group. The treatment consisted in abolishing all visual inputs from the right hemisphere for one week by means of specially devised hemiblinding goggles. Patients' visuospatial abilities were tested and compared between groups immediately after the week of treatment. Both groups were further assessed one week after treatment suspension for evaluation of long term beneficial effects.

Results: Following the treatment, a substantial amelioration of visuospatial neglect symptoms was selectively observed in the T+ group. In contrast, untreated patients showed only weak signs of recovery. Most important, the amelioration obtained in the T+ group of patients was not ephemeral, being significantly maintained after a further period of one week, even after suspension of the treatment.

Conclusion: The protracted efficacy of the proposed "hemiblinding technique" may have important implications for the recovery of visuospatial neglect and may be a very promising tool for investigating both the cognitive and the neural basis of neglect rehabilitation.

Unilateral visuospatial neglect is one of the most striking deficits of spatial cognition following right brain damage. Patients with neglect appear to ignore, forget, or turn away from the space on the left side, exhibiting difficulty in many daily activities.¹ In addition, the presence of neglect is frequently associated with hemiplegia or hemiparesis,² and is a negative prognostic factor in the recovery of a patient's motor deficits.^{3,4}

Two of the most accredited interpretations of neglect suggest that it reflects a deficit in leftward orienting of attention⁵ or a defective representation of the contralesional space.⁶ As stated by the premotor theory of attention,⁷ when the eyes move in a given direction, visual attention also moves in the same direction. Since eye movements are ipsilesionally biased in neglect,^{8,9} training patients to move their eyes towards the neglected side should improve neglect. This is because the increased frequency of leftwards eye movements would also increase the orientation of spatial attention to the left neglected space. Alternatively, neglect may result from an unbalanced competition between spatial representations.^{10,11} Owing to the brain lesion, ipsilesional space representations benefit from competitive advantages with respect to contralesional ones. Therefore, neglect should be improved by reducing this competitive advantage.

We tested the hypothesis that suppressing visual inputs from the ipsilesional hemisphere may ameliorate visuospatial deficits characterising the neglect syndrome. Indeed, this visual occlusion is known to increase the occurrence of contralesional eye movements,¹² and it may be effective in reducing

the unbalanced competition between spatial representations. Thus, a "hemiblinding technique" would potentially incorporate therapeutic effects derived from both the attentional and the representational view of neglect. In addition, we investigated whether a prolonged visual suppression could induce a long lasting amelioration.

METHODS

Eleven post-acute patients with neglect following right hemisphere vascular lesions participated in the present study. The investigation was run in two phases. In the first phase, eight patients with neglect were randomly assigned to two groups: an experimental group, which was treated for one week (T+), and a control group (T-). In the second phase, three patients with neglect were additionally investigated with the aim of better controlling the effect of potential demographic group differences on amelioration. Patients for the second phase were selected from a larger population of patients with neglect on the basis that they normally did not need to wear glasses, as was the case for the patients recruited in the first phase. One of the phase two patient was assigned to the T+ group (n = 5) and two were assigned to the T- group (n = 6). All patients were right handed and manifested left hemiplegia or hemiparesis. Visuospatial neglect was assessed through a battery of tests including line, letter, and bell cancellation tasks,^{13,14,15} a copy of a drawing,¹⁶ and line bisection.¹⁷ All tests were displayed on an A4 sheet of paper, except for the letter cancellation test (A3). Table 1 lists the cerebral areas affected by the lesion as documented by computed tomography, the presence of visual field defects, and further patient details.

The treatment consisted in wearing plastic goggles, similar to common swimming glasses, that were specially modified to ensure long term comfort. A right sided portion of each lens was "blinded". The vertical border line of this blinded zone was aligned with the vertical meridian of the patient's pupil while looking straight ahead. While patients were wearing these hemiblinding goggles, they had no visual information about the head centred right hemisphere.

Both groups of patients (T+ and T-) undertook the above described battery of tests in three sessions: the first at recruitment and the other two at weekly intervals. The T+ group permanently wore hemiblinding goggles (removed only before going to sleep) throughout the first week. During the second week, T+ patients didn't wear the goggles. In the T- group, patients never wore hemiblinding goggles. Testing sessions were always performed without goggles. All patients were involved in the hospital's daily activities throughout the investigation. Both groups also underwent the same specific treatment of neglect usually used in the hospital. This consisted of standard tasks designed to compensate for faulty scanning habits.¹⁸

Abbreviations: T+, treatment group; T-, control group

Table 1 Clinical and demographic details of patients with right brain damage

Patients by group	Sex	Age (years)	Education (years)	Months after stroke	Visual field defects	Lesion site
Treatment group						
1	M	63	5	3	+	F T P
2	M	70	5	24	+	F T P
3	M	68	5	5	–	F T
4	M	74	13	13	+	F P
5	F	78	4	1	+	T P
Control group						
1	M	72	5	4	+	T P
2	M	69	5	5	+	F T P O
3	F	80	3	2	–	P
4	F	84	3	7	+	T O
5	M	71	5	1	+	P
6	M	63	5	4	+	B G

+, presence of hemianopia, as assessed by means of Goldman perimetry; –, absence of hemianopia, as assessed by means of Goldman perimetry. Lesion site column indicates the cerebral lobe or structure involved by the lesion: BG, basal ganglia; F, frontal; O, occipital; P, parietal; T, temporal.

Table 2 Mean accuracy (%) for each group

Test	Treatment group			Control group		
	Session 1	Session 2	Session 3	Session 1	Session 2	Session 3
Albert	33	90	83	40	50	53
Letters	10	11	16	11	9	13
Bells	13	26	29	17	18	22
Drawing (I)	24	40	36	43	37	47
Drawing (II)	12	20	24	17	13	17
Line bisection	27	35	36	42	39	44

Drawing (I), items drawn by the patient; Drawing (II), items drawn symmetrically.

RESULTS

For each group, accuracy was calculated as a function of test and session (table 2). The accuracy score in the cancellation tests reflected the proportion of items correctly cancelled. The two scores obtained in the drawing test reflected the percentage of items drawn by the patient (I) and the percentage of items drawn symmetrically (II). In the line bisection task, accuracy was calculated as maximal (100% correct) if a patient crossed the real centre of the line, progressively decreasing as a function of rightward deviation.

The mean percentage of accuracy was arcsine transformed and submitted to a three way analysis of variance with group (T+ or T–) as the between subjects factor and session (1, 2, or 3) and test (six scores) as the within subjects factors. The group \times session interaction was highly significant ($F(2,18) = 11.8$, $p < 0.0006$) and was further explored with Neuman-Keuls post hoc test. Neglect symptoms were considerably ameliorated by the treatment (fig 1). At the second testing session, after one week of treatment, T+ patients' performance was much better than at the first session (37% and 20% correct, respectively, $p < 0.0003$). In contrast, T– patients' performance was unchanged after the same time interval (28% and 28% correct, respectively). Further, although at the first session neglect severity was higher in the T+ than in the T– group (T+, 20%; T–, 28% correct, $p < 0.04$), T+ group accuracy after the week of treatment was significantly better than that of the T– group (T+, 37%; T–, 28% correct, $p < 0.005$), thus reversing the groups' pattern of performance (fig 1).

It was most interesting that the improvement was clearly protracted after treatment. At the third session, after one week during which patients did not wear hemiblinding goggles, the improvement shown in the T+ group (37%) was fully maintained relative to the second session (37%) and, crucially, patients' performance was still strongly better than at the first

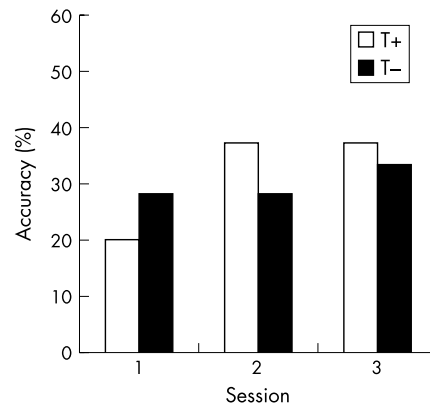


Figure 1 Mean percentage of accuracy for the treated (T+) and control (T–) groups in sessions 1, 2, and 3, assessed at weekly intervals.

session (37% and 20%, $p < 0.0003$). Overall, the control group showed only small signs of recovery across the three sessions (session 1, 28%; 2, 28%; 3, 33% correct) that were evident mainly in the cancellation tests, as suggested by the session \times test significant interaction ($F(10,90) = 3.2$, $p < 0.002$). As shown in table 2, these tests appeared to be globally better performed at the third than in the first session ($p < 0.03$ in all comparisons). The group \times session \times test interaction was not significant.

An additional analysis of variance was conducted on the mean percentage of accuracy of each test, with group (T+, T–) as the between subjects factor and session (1, 2, 3) as the within subjects factor. The main effect of session was significant in the letter and bell cancellation tests (both $p < 0.04$), showing a global increase in accuracy between the first and

the third session ($p < 0.04$ in all comparisons). The pattern of results of the remaining tests was similar to that found in the former analysis, showing in the T+ group better performance at sessions 2 and 3 than at session 1. However, differences were marginally significant, clearly reaching significance only in the Albert test, in which the group \times session interaction ($F(2,18) = 13.98$, $p < 0.0003$) confirmed that the amelioration was selectively present in the T+ group. Indeed, the apparent amelioration shown by the T- group across sessions (table 2) was not significant ($p \geq 0.2$ in all comparisons). In contrast, a clear improvement was present in the T+ group after one week of treatment (first versus second session, $p < 0.0002$) that also was maintained after one week of treatment interruption (first versus third session, $p < 0.0002$). This durable effect was further confirmed by the fact that the T+ patients' performance did not differ between the second and the third session ($p \geq 0.4$). Finally, the T+ patients' accuracy was significantly better than that of T- patients at the third session (T+, 83% versus T-, 53%, $p < 0.0004$), even though the groups' performance in this test was comparable at the first session (T+, 33% versus T-, 40%).

DISCUSSION

The present study shows that visual neglect can be significantly reduced by "blinding" patients' ipsilesional hemispace. After a one week long visual occlusion of the right hemispace, according to head centred spatial coordinates, the T+ group showed an important improvement of neglect symptoms. The selectivity and efficacy of the treatment were particularly evident from the Albert test, for which a strong amelioration of neglect symptoms was seen in treated patients, whereas the T- group showed a small, non-significant amelioration. Most important, the improvement of neglect found in the T+ group was not ephemeral, being fully maintained one week after the treatment had been suspended.

These results suggest that the hemiblinding technique may be very effective for neglect rehabilitation. Owing to the relatively small number of patients investigated, however, possible limitations of this preliminary study should be considered before discussing theoretical and practical implications of this new approach. The age of the patients was comparable between T+ and T- groups (71 and 73 years, respectively), as was their level of education (six and four years), while treated patients tended to be in a more chronic phase (nine and four months; table 1). However, none of these differences was significant, and future studies would help to clarify whether (some of) these factors may interact with the treatment.

It is important to consider the mechanism through which the amelioration due to the hemiblinding technique may be achieved and maintained. By referring to the previously described interpretations of neglect, we suggest that the efficacy of this technique may rely on the increased occurrence of contralesional eye movement or the reduction of the competitive advantage of the ipsilesional spatial representation. It is conceivable that the long lasting improvement we documented derives from the conjunctive beneficial effect of orienting spatial attention to the left and reducing spatial competition. Since repetitive execution of contralesional eye turns is not sufficient per se to ameliorate neglect,¹⁹ their goal directed execution, aimed at sensibly interacting with the environment, may be a key element in achieving stable improvement. Moreover, since partial visual reduction of the right space does not improve neglect,²⁰ we suggest that a total suppression of this visual input may be necessary to recover visuospatial neglect.

Furthermore, the prolonged ipsilesional blinding may have induced subtle head or trunk postural changes or increased the general level of arousal. Both instances may have contributed to improving neglect in the T+ group.^{21, 22} In addition, the possible interactive part played by hemianopia in neglect

recovery through the hemiblinding technique should be evaluated in future studies.²³ Hemianopia was present in 82% of treated and non-treated patients, and we agree with an anonymous referee in arguing that hemianopic patients with neglect may benefit from this treatment even more than patients without visual field defects. Indeed, leftward eye turns should increase especially in left hemianopic right blinded patients who otherwise would become completely blind.

While at present it is difficult, and beyond the scope of this preliminary study, to comparatively evaluate the contribution of these factors in ameliorating neglect, it appears clear that the hemiblinding technique, by potentially embodying all these multiple components, may be a very promising tool for neglect rehabilitation.

A final, important aspect of the hemiblinding procedure is distinctive with respect to other "cognitive"^{24, 25} and "physiological" treatments.²⁶⁻³¹ Most of them usually train patients in specific tasks, investigating afterwards the possible generalising effects in more naturalistic situations.³² In contrast, here we allowed patients to go through a "self made" rehabilitation training while performing daily hospital activities, whereas the improvement was evaluated by means of specific tasks. It follows that this is a really naturalistic training that, in addition, does not require devoting any extra staff or time to patient rehabilitation.

ACKNOWLEDGEMENTS

We thank M Dainelli, S Fruzzetti, and M Lamponi for their helpful collaboration. We also thank F Bassignani, A Belluomini, N Dalla Costa, P Gemignani, and B Giachi for their contribution during data collection; we are grateful to E Ládavas, F Pavani, and three anonymous referees for their valuable comments on an earlier version of the manuscript.

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Received 3 July 2000
In revised form 16 April 2002
Accepted 30 April 2002

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